Astrophysics Research And Analysis

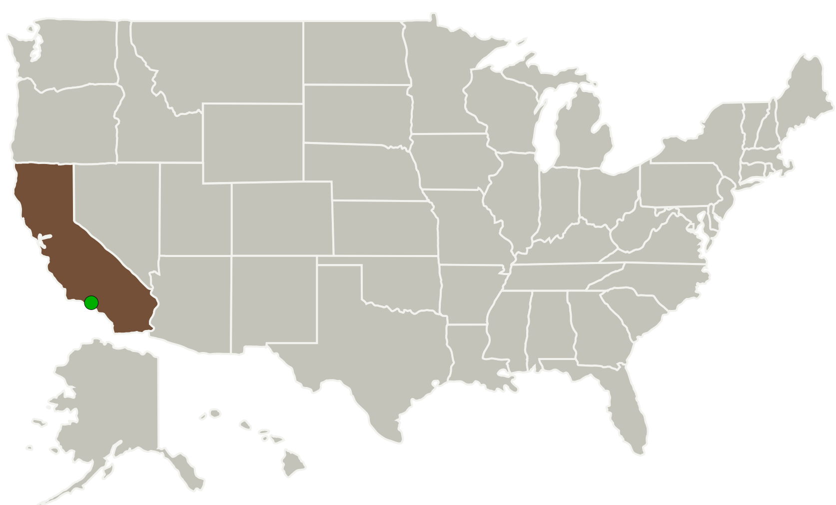
Silicon Metasurfaces for Integrated Dual Polarized 1.9 THz Heterodyne Array Instruments

Completed Technology Project (2017 - 2020)

Project Introduction

We propose the use of dielectric metasurfaces as the enabling technology to develop a dual polarized heterodyne receiver array with full mapping of the field of view at 1.9 THz. Current heterodyne and non-heterodyne arrays at 1.9 THz are restricted to have sparse mapping in the field of view due to the minimum physical inter-element spacing required between the pixels. Moreover, an integrated dual polarized heterodyne receiver is very difficult to achieve with current technologies at 1.9 THz. We propose the use of metasurfaces that will split the 1.9 THz radiation into two linear polarizations and focus them both on the same receiver plane. Additionally, by overlapping common regions of the metasurface we will have a full mapping of the field of view, i.e. the beams will be highly overlapped in the field of sky observation which is not the case with current generation of array instruments. The metasurface consists of a dielectric planar structure with subwavelength 3D features that controls the amplitude and phase of the electric field that goes through them. These structures are usually used in reflection in the microwave frequency range and has not been used at terahertz frequencies before. We propose the development of these metasurfaces in transmission and integrate them into a multi-pixel heterodyne receiver at 1.9 THz. The silicon micro-machining process developed at JPL allows the fabrication of high aspect ratio multi-depth features on silicon wafers and will allow the integration of both, receiver and metasurfaces, in the same wafer stack. It will lead to a more compact, low-mass, and low loss dual polarized multi-pixel receiver with efficient illumination at 1.9 THz. Even though this work will target the 1.8-2.1 THz band for the CII and OI lines, these designs can be easily scaled to at least 5 THz.

Primary U.S. Work Locations and Key Partners



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Organizational Responsibility

Responsible Mission Directorate:

Science Mission Directorate (SMD)

Lead Organization:

California Institute of Technology (CalTech)

Responsible Program:

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Organizations Performing Work	Role	Type	Location
California Institute of Technology(CalTech)	Lead Organization	Academia	Pasadena, California
Jet Propulsion Laboratory(JPL)	Supporting Organization	NASA Center	Pasadena, California

Primary U.S. Work Locations
California

Project Management

Program Director:
Michael A Garcia

Program Manager:
Dominic J Benford

Principal Investigator:
Maria Alonso Del Pino

Co-Investigators:
Andrei Faraon
Paul F Goldsmith
Karen R Piggee
Theodore J Reck
Cecile Jung-kubiak
Goutam Chattopadhyay

Technology Areas

Primary:

- TX08 Sensors and Instruments
  └ TX08.1 Remote Sensing Instruments/Sensors
    └ TX08.1.4 Microwave, Millimeter-, and Submillimeter-Waves

Target Destination
Outside the Solar System